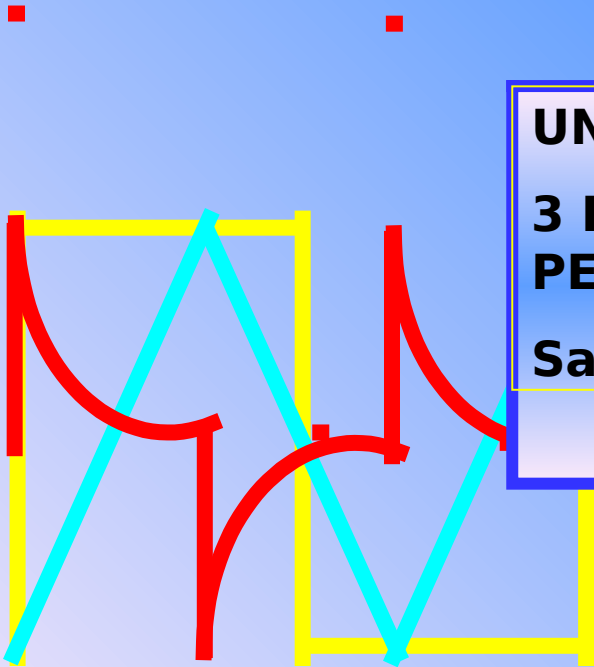


AC:

Transients in RC Circuits



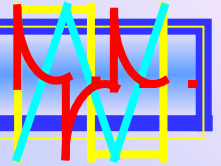
UNCLASSIFIED;

3 Hour Conference W/1 Hr PE3 & 3 Hr PE1

Safety & Environmental Impact; LOW.

AC:

Transients in RC Circuits



Terminal Learning Objective

ACTION;

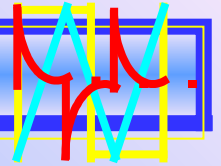
Given an RC Ckt, calculate for Time Constant, Pulse Width, TC PW ratio, the type of Ckt and the output wave form.

CONDITIONS;

With Official OMEMS Training Aid reference.
{ White }

STANDARD;

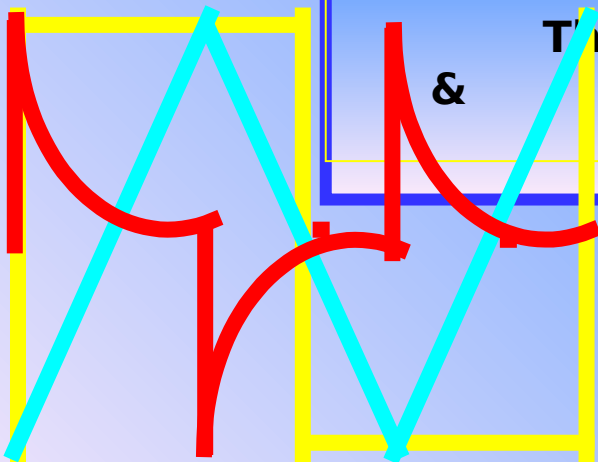
A minimum accuracy of 7 correct answers out of 10 questions.



Introduction

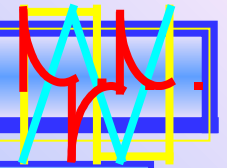
This lesson will enable you to determine what type of ckt is being used based upon the size of the Resistor & Capacitor which will change the input waveform to a distinctly different waveform at the output.

& These circuits are used extensively in private defense electronics for timing devices.



AC:

Transients in RC Circuits

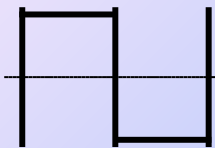


RC Ckt;

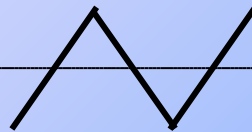
A Ckt comprising of a Resistor & Capacitor in series where the rate [time] of Charge & Discharge is dictated by the value [size] of the Resistor & Cap.

Transient Waveform;

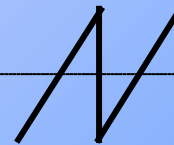
A waveform that changes from one steady state to another or is positive for a period of time, then Negative for an equal period of time. A Sine wave is not a transient waveform.



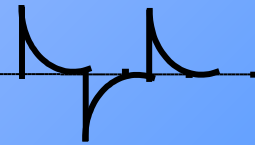
Square



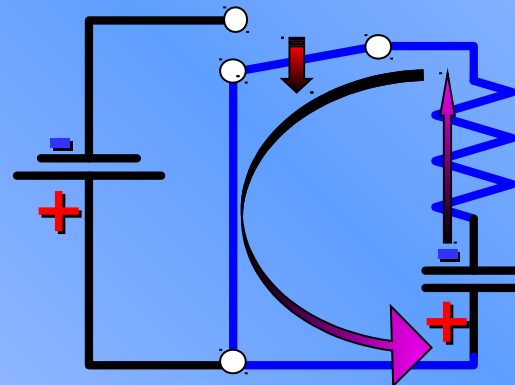
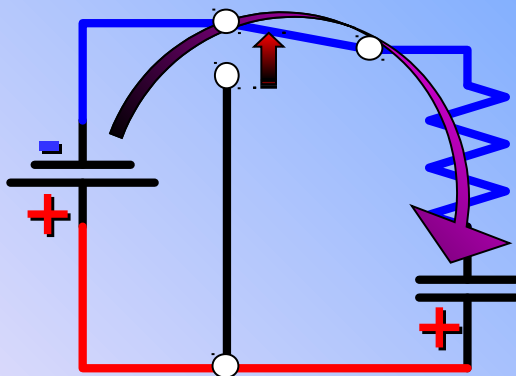
Triangular



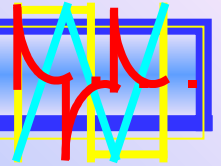
Saw tooth



Spike



TC



Time Constant;

The rate [time] of Charge & Discharge dictated by the value [size] of the Resistor & Cap.

The **TC** is measured in units of Seconds, Expressed in μ
Sec only.

1 Time Constant [TC] is the amount of time required for a Capacitor to charge to 63% of the Applied Voltage.

$$\mathbf{TC = R \times C} \text{ in Micro Seconds}$$

$$\mathbf{R = 10 \text{ K}\Omega} \quad \mathbf{C = .001 \mu f}$$

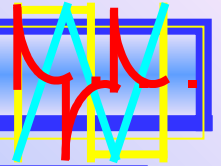
$$\mathbf{10 \text{ EE}^3 \times .001 \text{ EE}^{-6} = .00001 \text{ Sec} = 10 \mu \text{S}}$$

Move the decimal 6 places. **.000010.**

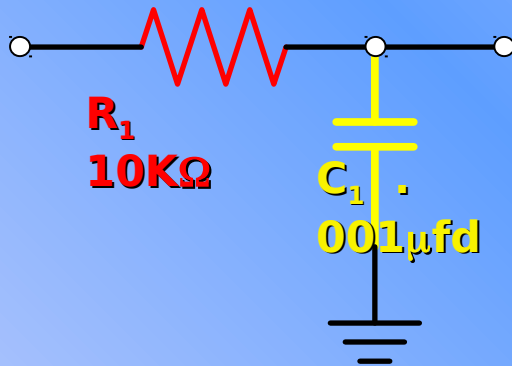
On the calculator; 2nd Function 6 $\Rightarrow 10^{-6}$

AC:

Transients in RC Circuits



Calculate the TC for the following Ckt values.



$$TC = R \times C$$

$$10 \text{ EE}^3 \times .001 \text{ EE}^{-6} = .00001 \Rightarrow TC = 10 \mu\text{Sec}$$

$$R = 5 \text{ K}\Omega$$

$$C = .001 \mu\text{f}$$

$$TC = \underline{\hspace{2cm}}$$

$$C = .001 \mu\text{f}$$

$$TC = \underline{\hspace{2cm}}$$

$$R = 10 \text{ K}\Omega$$

$$C = .1 \mu\text{f}$$

$$TC = \underline{\hspace{2cm}}$$

$$R = 1 \text{ K}\Omega$$

$$C = .01 \mu\text{f}$$

$$TC = \underline{\hspace{2cm}}$$

$$C = .01 \mu\text{f}$$

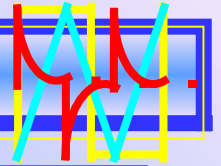
$$TC = \underline{\hspace{2cm}}$$

$$R = 20 \text{ K}\Omega$$

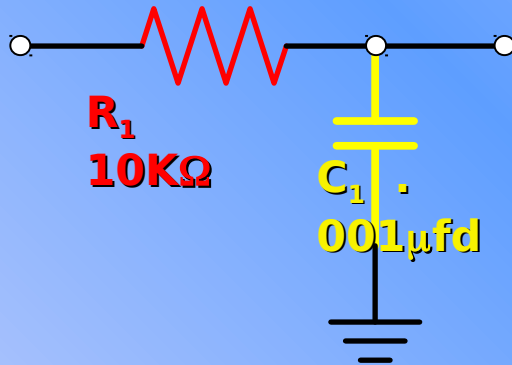
Answers

AC:

Transients in RC Circuits



Calculate the TC for the following Ckt values.



$$TC = R \times C$$

$$10 \text{ EE}^3 \times .001 \text{ EE}^{-6} = .00001 \Rightarrow TC = 10 \mu\text{Sec}$$

$$R = 5 \text{ K}\Omega$$

$$C = .001 \mu\text{S}$$

$$TC = 5 \mu\text{S}$$

$$R = 10 \text{ K}\Omega$$

$$C = .001 \mu\text{S}$$

$$TC = 10 \mu\text{S}$$

$$TC = 100 \mu\text{S}$$

$$R = 1 \text{ K}\Omega$$

$$C = .1 \mu\text{S}$$

$$TC = 200 \mu\text{S}$$

$$R = 20 \text{ K}\Omega$$

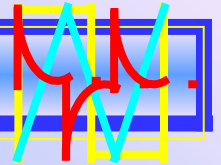
$$C = .01 \mu\text{S}$$

$$TC = 100 \mu\text{S}$$

TC Chart

AC:

Transients in RC Circuits

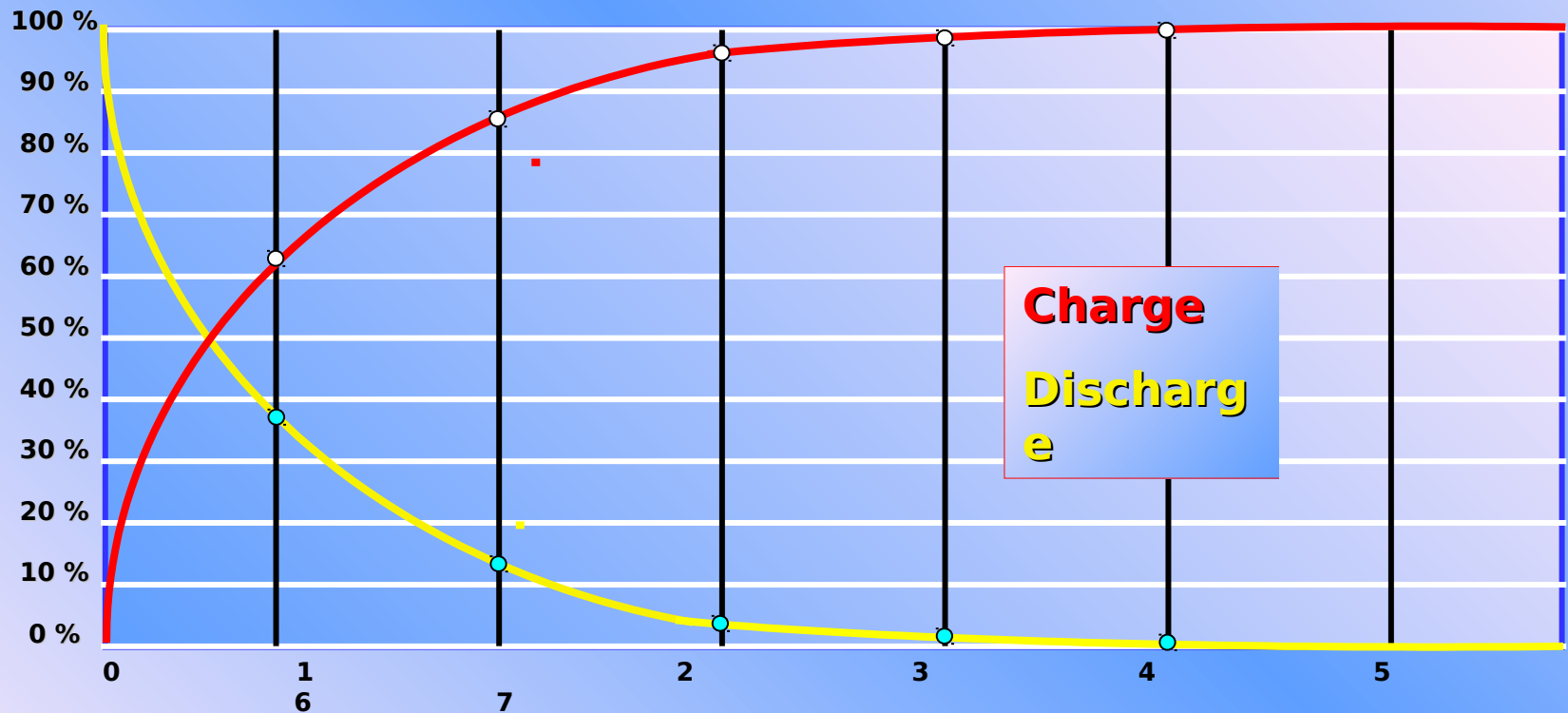


Time Constant Chart;

1 TC = 63%

4 TC = 37%

5 TC = 100%



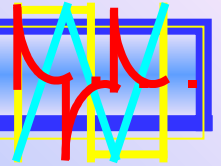
Charge
Discharge

**Reference, White Government Tng
Aid.**

Job 1:

AC:

Transients in RC Circuits



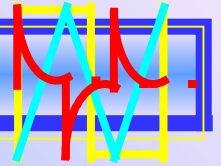
JOB 1; Calculate the TC for the following problems. All answers must be in μS .

- | | | | |
|----|-------------------------------------|---|-------------------|
| a. | R = 10 KΩ | C = 1 μf | TC = _____ |
| b. | R = 5 KΩ | C = 5 μf | TC = _____ |
| c. | R = 100 Ω | C = .5 μf | TC = _____ |
| d. | R = 1 KΩ | C = 1 μf | TC = _____ |
| e. | R = 100 KΩ | C = 100 μf | TC = _____ |
| f. | R = 500 Ω | C = 1 μf | TC = _____ |
| g. | R = 20 KΩ | C = 100 μf | TC = _____ |
| h. | R = 50 KΩ | C = .01 μf | TC = _____ |
| i. | R = 50 Ω | C = 3 μf | TC = _____ |
| j. | R = 10 MΩ | | |

Answers

AC:

Transients in RC Circuits

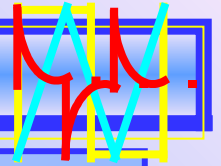


JOB 1; Calculate the TC for the following problems. All answers must be in μS .

- | | | | |
|----|---|---|--|
| a. | $R = 10 \text{ K}\Omega$ | $C = 1 \mu\text{f}$ | $\text{TC} = 10,000 \mu\text{S}$ |
| b. | $R = 5 \text{ K}\Omega$ | $C = 5 \mu\text{f}$ | $\text{TC} = 25,000 \mu\text{S}$ |
| c. | $R = 100 \Omega$ | $C = .5 \mu\text{f}$ | $\text{TC} = 50 \mu\text{S}$ |
| d. | $R = 1 \text{ K}\Omega$ | $C = 1 \mu\text{f}$ | $\text{TC} = 1,000 \mu\text{S}$ |
| e. | $R = 100 \text{ K}\Omega$ | $C = 100 \mu\text{f}$ | $\text{TC} = 10,000,000 \mu\text{S}$ |
| f. | | $C = 1 \mu\text{f}$ | |
| g. | $R = 500 \Omega$ | $C = 100 \mu\text{f}$ | $\text{TC} = 500 \mu\text{S}$ |
| h. | $R = 20 \text{ K}\Omega$ | $C = .01 \mu\text{f}$ | $\text{TC} = 2,000,000 \mu\text{S}$ |
| i. | $R = 50 \text{ K}\Omega$ | $C = .1 \mu\text{f}$ | $\text{TC} = 500 \mu\text{S}$ |
| j. | $R = 50 \Omega$ | $C = 3 \mu\text{f}$ | $\text{TC} = 5 \mu\text{S}$ |
| | $R = 10 \text{ M}\Omega$ | | $\text{TC} = 30,000,000 \mu\text{S}$ |

AC:

Transients in RC Circuits



Pulse Width;

$$PW = \frac{1}{2 F}$$

$$PW = \frac{1}{2 \times \text{Freq}}$$

On the Calculator; Frequency = 50 KHz

$$50 \text{ EE}^3 \times 2 = 1/X \Rightarrow .00001 \text{ Sec}$$

$$PW = .0000 \boxed{10} \mu S$$

W/ 2nd Function Key; **PW** = 10^{-6}

PW Must be in μS

1 KHz **PW** = _____

5 KHz **PW** = _____

10 KHz **PW** = _____

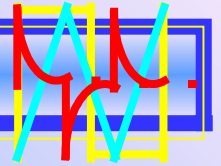
20 KHz **PW** = _____

50 KHz **PW** = _____

Job 2:

AC:

Transients in RC Circuits



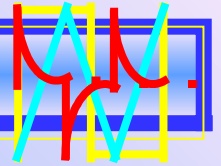
JOB 2; Calculate the **PW of the following Frequencies.**

- | | | |
|----|-------------------|-------------------|
| a | F = 1 KHz | PW = _____ |
| . | F = 100 Hz | PW = _____ |
| b | F = 55 KHz | PW = _____ |
| . | F = 100 | PW = _____ |
| c. | KHz | PW = _____ |
| d | F = 1 MHz | PW = _____ |
| . | F = 60 KHz | PW = _____ |
| e | F = 10 KHz | PW = _____ |
| . | F = 1000 | PW = _____ |
| f. | Hz | PW = _____ |
| g | F = 5 KHz | PW = _____ |
| . | F = 25 KHz | PW = _____ |
| h | | |
| . | | |

Answers

AC:

Transients in RC Circuits

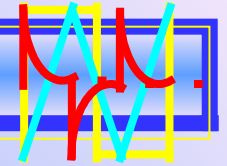


JOB 2; Calculate the **PW of the following Frequencies.**

a	F = 1 KHz	PW = 500 μS
.	F = 100 Hz	PW = 5000 μS
b	F = 55 KHz	PW = 9.09 μS
.	F = 100 KHz	PW = 5 μS
c.	F = 1 MHz	PW = .5 μS
.	F = 60 KHz	PW = 8.33 μS
e	F = 10 KHz	PW = 50 μS
.	F = 1000 Hz	PW = 100 μS
f.	F = 5 KHz	PW = 20 μS
.	F = 25 KHz	
g		
.		
h		
.		

AC:

Transients in RC Circuits



TC to PW Ratio;

TC = Time
Needed

PW = Time
Have

The TC tells us how much time is
NEEDED to charge a Capacitor to
63% of the Applied Voltage.

The **PW** tell us how much time we
HAVE to charge a Capacitor to
63% of EA.

Reduce the Fraction; $TC = 10 \mu S \Rightarrow \frac{10}{100} \Rightarrow \frac{1}{10}$

Strike out the common 0

$100 \Rightarrow 10$

$PW = 100 \mu S \Rightarrow$

Reduce the Fraction;

10 will go into 100, 10 times
 $\frac{100}{10} = 10$

$\frac{10 \mu S}{100 \mu S} \Rightarrow \frac{1}{10}$

$\frac{10 \mu S}{100 \mu S} \Rightarrow \frac{1}{10}$

10 will go into 10, 1 time

$100 \mu S$

10

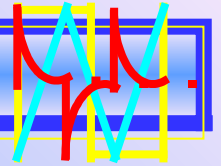
Note;

All
fraction
s must
be
reduced
to the
lowest
term of
1/# or
#/1

TC/PW

AC:

Transients in RC Circuits



TC to PW Ratio;

TC = Time
Needed

[≤]

$$\frac{1}{10}$$

Short

Plenty of time to
charge the Cap

PW = Time
Have

TC = Time
Needed

[≥]

$$\frac{1}{0}$$

Long

Does not allow
the Cap to fully
charge.

PW = Time
Have

TC = Time
Needed

[=]

$$\frac{1}{1}$$

Medium

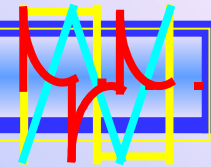
Use in this lesson
today. No
practical
application.

PW = Time
Have

TC/PW Chart

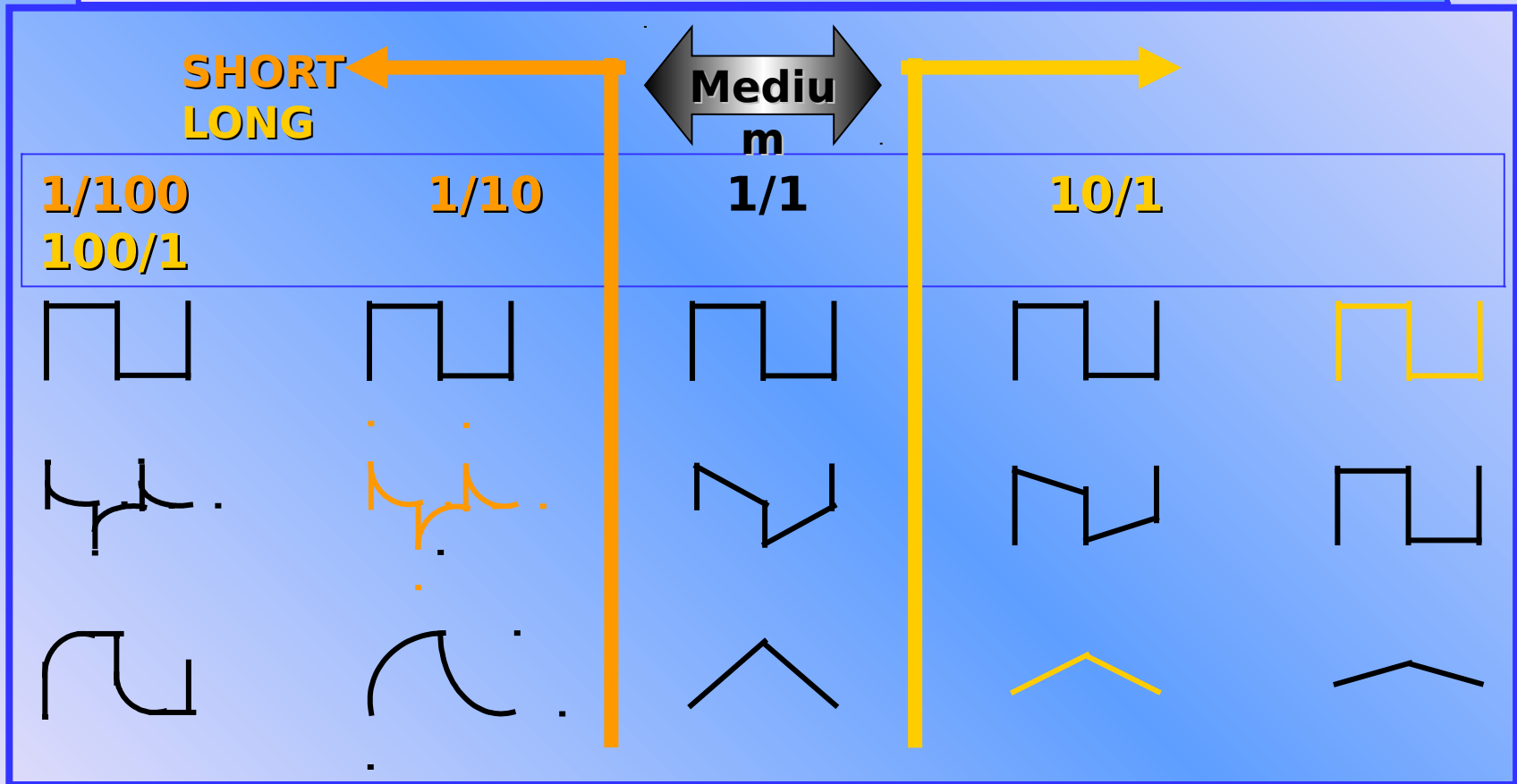
AC:

Transients in RC Circuits



**TC to PW Chart;
Aid.**

Reference White Gov Tng

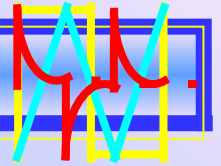


9/1 to 1/9 is
Medium

Challenge

AC:

Transients in RC Circuits



Challenge Problem; Calculate the TC/PW Ratio & Identify if it is Short, Medium or Long.

TC = 10 μ S PW = 200 μ S TC/PW = _____

TC = 50 μ S PW = 50 μ S TC/PW = _____

TC = 100 μ S PW = 10 μ S TC/PW = _____

TC = 25 μ S PW = 100 μ S TC/PW = _____

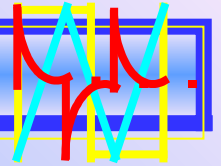
TC = 60 μ S PW = 600 μ S TC/PW = _____

Reference White Gov Tng Aid.

Answers

AC:

Transients in RC Circuits



Challenge Problem; Calculate the TC/PW Ratio & Identify if it is **Short, Medium or **Long**.**

TC = 10 μ S PW = 200 μ S TC/PW = 1/20 **Short**

TC = 50 μ S PW = 50 μ S TC/PW = 1/1 **Medium**

TC = 100 μ S PW = 10 μ S TC/PW = 10/1 **Long**

TC = 25 μ S PW = 100 μ S TC/PW = 1/4 **Medium**

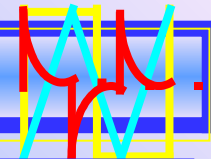
TC = 60 μ S PW = 600 μ S TC/PW = 1/10 **Short**

Reference White Gov Tng
Aid.

Job3:

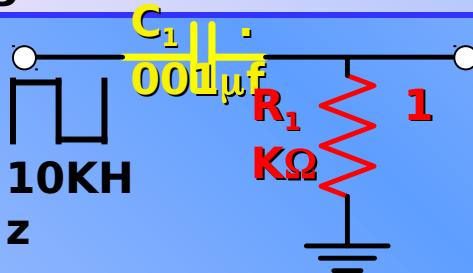
AC:

Transients in RC Circuits



JOB 3; Calculate the TC/PW, Ratio & Identify as Short, Medium or Long.

a.



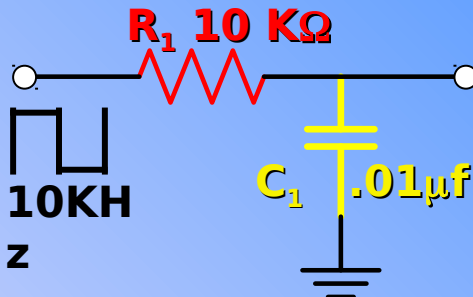
TC:

PW:

Ratio:

Identify:

b.



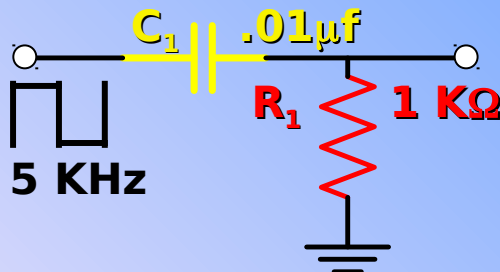
TC:

PW:

Ratio:

Identify:

c.



TC:

PW:

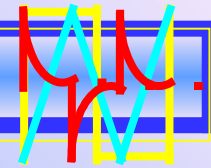
Ratio:

Identify:

Answers; a - c

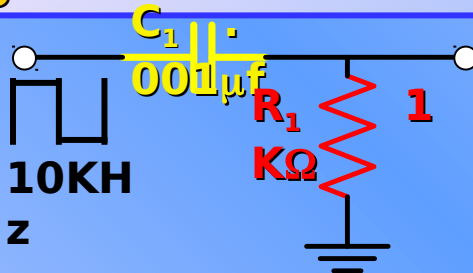
AC:

Transients in RC Circuits



JOB 3; Calculate the TC/PW, Ratio & Identify as **Short**, Medium or **Long**.

a.



TC:

1 μ S

PW:

50 μ S

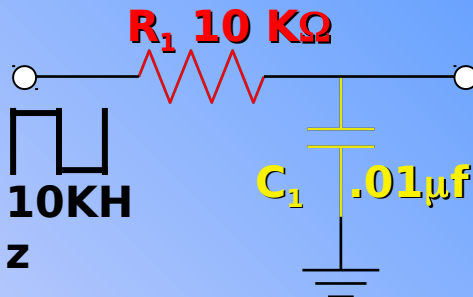
Ratio:

1/50

Identify:

Short

b.



TC:

100 μ S

PW:

50 μ S

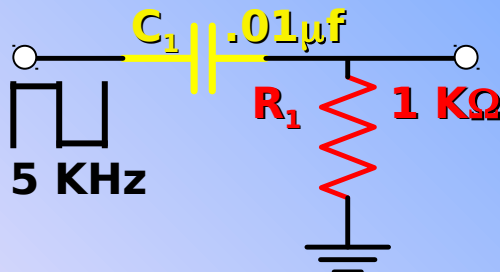
Ratio:

2/1

Name Ckt:

Med [Long]

c.



TC:

10 μ S

PW:

100 μ S

Ratio:

1/10

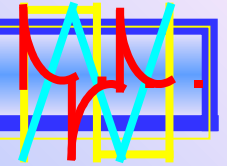
Name Ckt:

Short

Job3: d, e

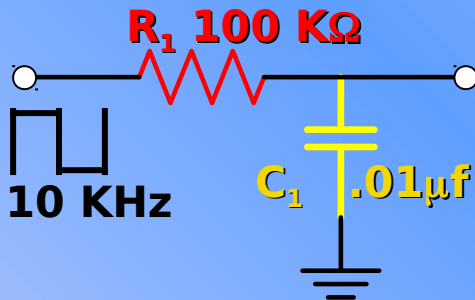
AC:

Transients in RC Circuits



JOB 3; Calculate the TC/PW, Ratio & Identify as Short, Medium or Long.

d.



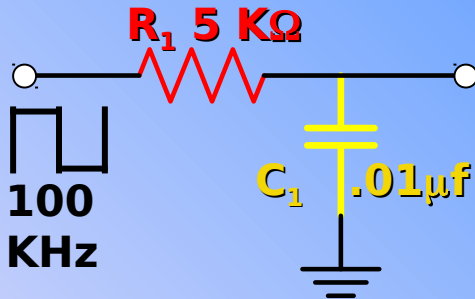
TC: _____

PW: _____

Ratio: _____

Identify: _____

e.



TC: _____

PW: _____

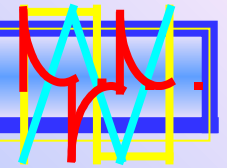
Ratio: _____

Identify: _____

Answers; d, e

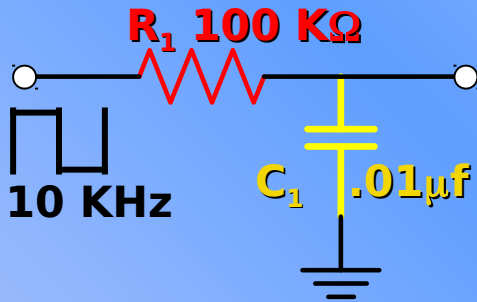
AC:

Transients in RC Circuits



JOB 3; Calculate the TC/PW, Ratio & Identify as **Short, Medium or **Long**.**

d.



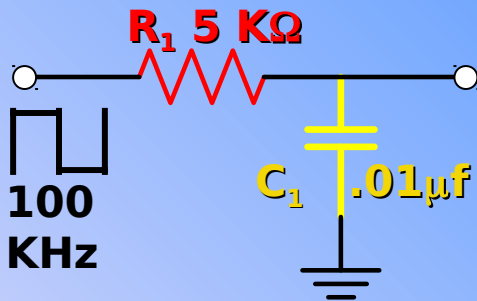
TC: 1000 μ S

PW: 50 μ S

Ratio: 20/1

Identify:
long

e.



TC: 50 μ S

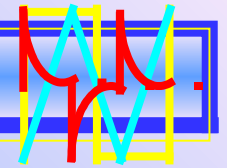
PW: 5 μ S

Ratio: 10/1

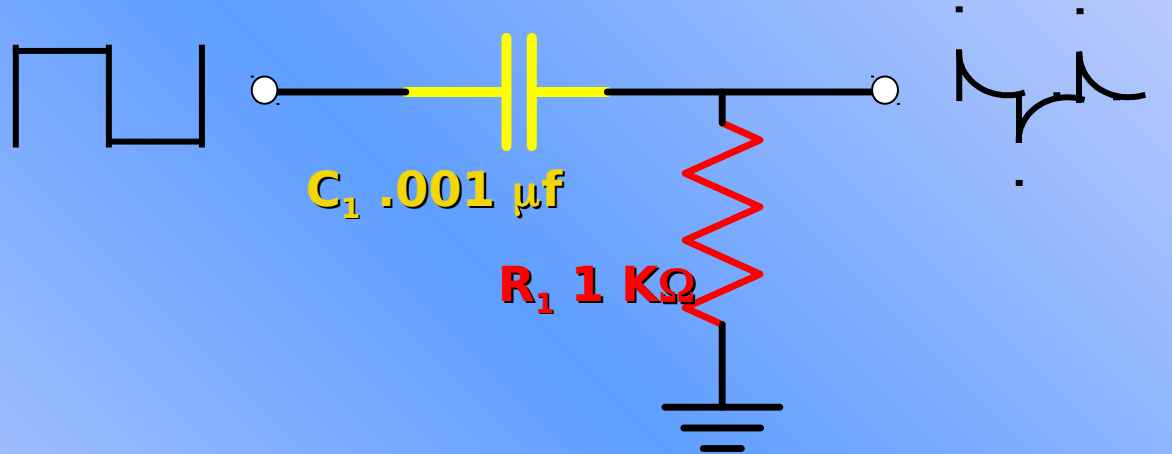
Identify:
long

AC:

Transients in RC Circuits



Differentiator;



Output taken across;
Resistor

TC/PW ;

Short

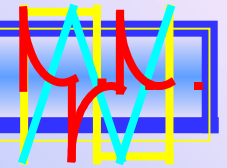
**Output waveform;
Spiked**

Reference White Gov Tng
Aid.

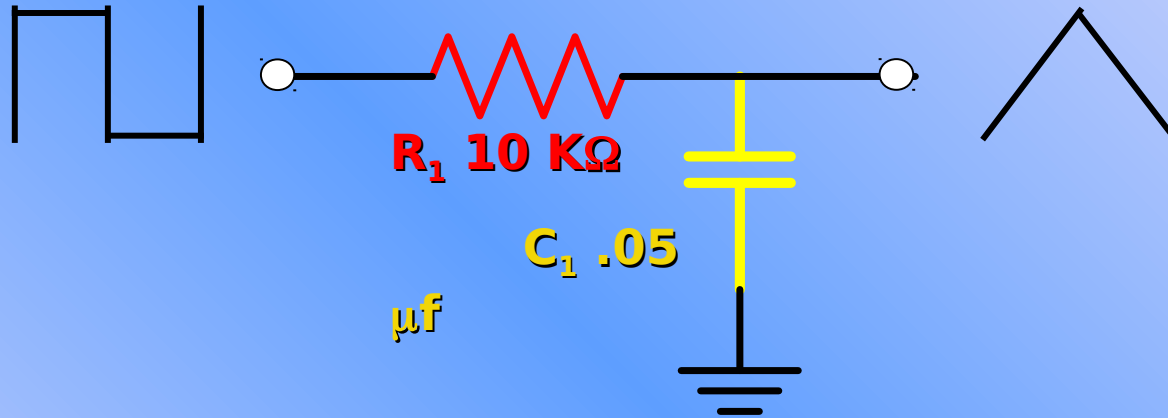


AC:

Transients in RC Circuits



Integrator;



Output taken across;
Capacitor

TC/PW ;

Long

Reference White Gov Tng
Aid.

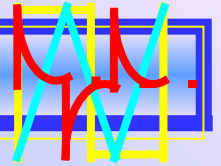
Note: The Integrator is unique in the fact that it is the only one of the three Ckts where the output is taken across the Capacitor, in reference to Gnd.

Output waveform;
Triangular

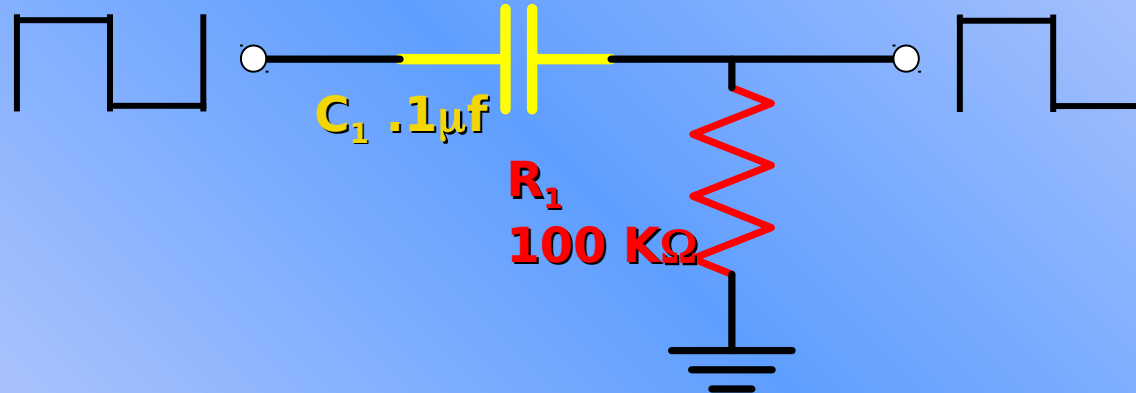


AC:

Transients in RC Circuits



Coupler;



Output taken across;
Resistor

TC/PW ; **Long**

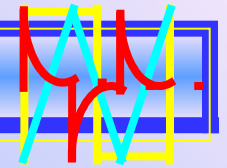
Output waveform;
Square

Reference White Gov Tng
Aid.

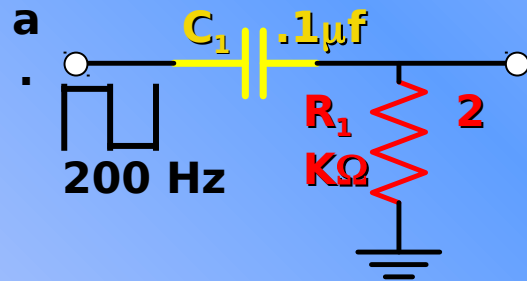
Job 4:

AC:

Transients in RC Circuits



JOB 4; Calculate the TC/PW, Ratio, & Name the Ckt. .



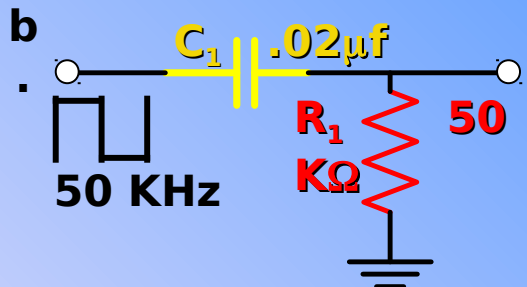
Output Component: _____

TC: _____

PW: _____

Ratio: _____

Name Ckt: _____



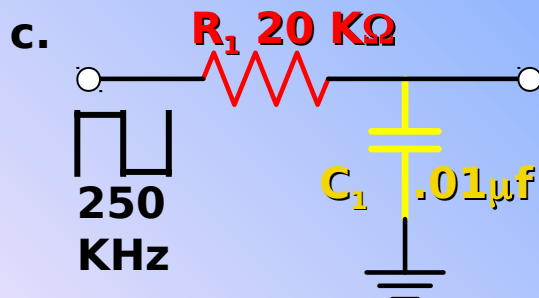
Output Component: _____

TC: _____

PW: _____

Ratio: _____

Name Ckt: _____



Output Component: _____

TC: _____

PW: _____

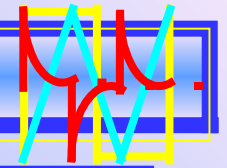
Ratio: _____

Name Ckt: _____

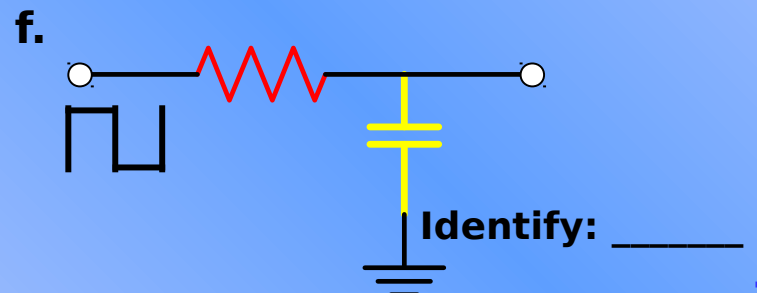
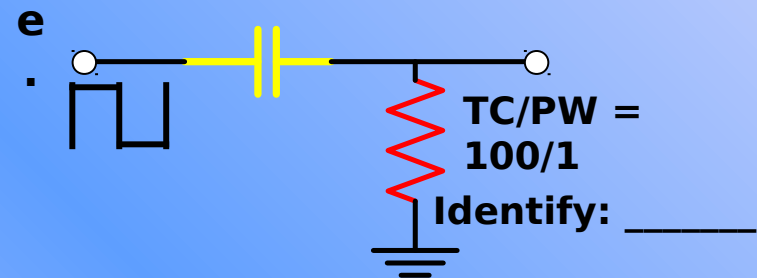
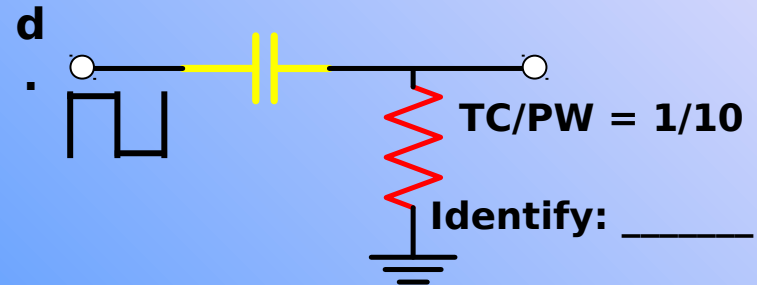
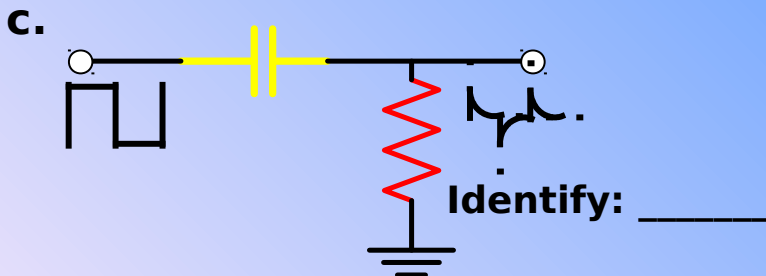
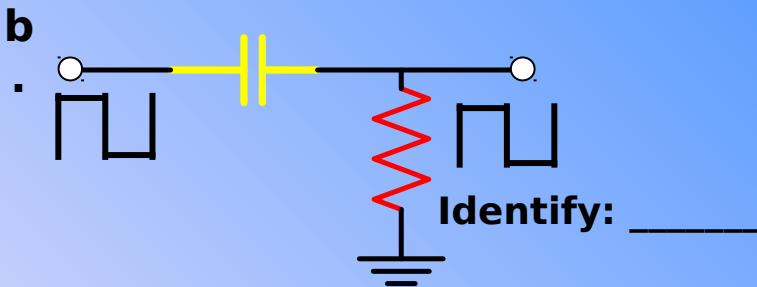
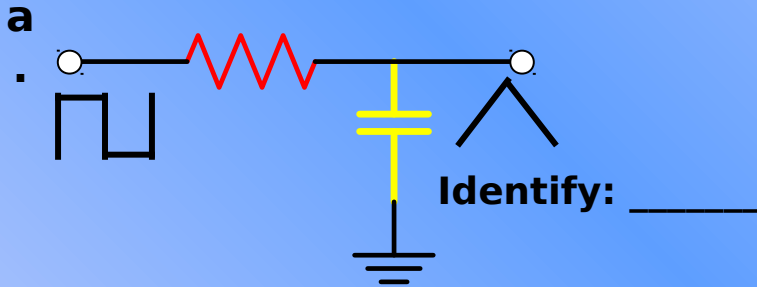
Answers

AC:

Transients in RC Circuits



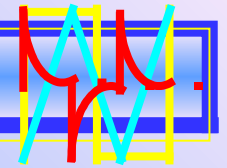
JOB 5; Identify the following Ckts.



Answers

AC:

Transients in RC Circuits



Review;

Reference White Gov Tng Aid.

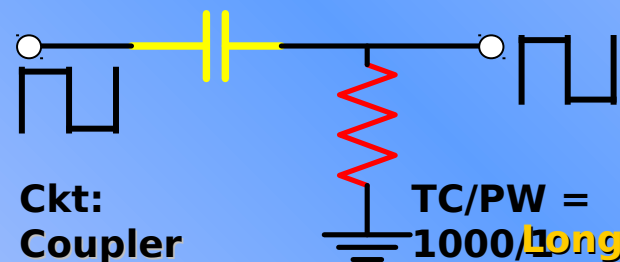
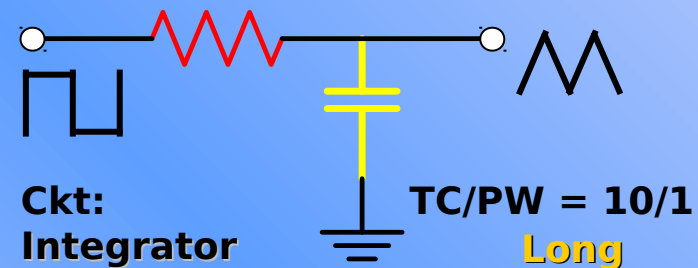
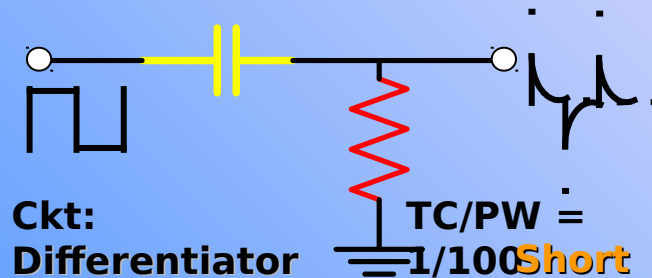
$$TC = R \times C$$

$$PW = \frac{1}{2 \times Freq}$$

TC/PW Ratio,
reduce fraction.

$$TC = \frac{\text{Time Needed}}{\quad}$$

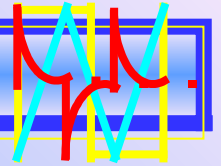
PW = Time
Have



Close

AC:

Transients in RC Circuits



SUMMARY & QUESTIONS;

LESSON TEST;

Time; 20 Minutes.

**References; Official OMEMS
Training Aids.**

**Standard; 7 of 10 correct
answers minimum.**